Document No. 2872

DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

CHAPTER 61

Statutory Authority: S.C. Code Section 48-1-10 et seq.

R.61-62, *Air Pollution Control Regulations and Standards*

Synopsis:

On July 18, 1997, the United States Environmental Protection Agency (EPA) revised the National Ambient Air Quality Standard for ground-level ozone from 0.12 parts per million (ppm) 1-hour "peak" standard to 0.08 ppm 8-hour "average" standard. The National Ambient Air Quality Standards are health - based standards established at levels intended to protect public health. This "new" ozone standard is commonly referred to as the 8-hour ozone standard. Currently, all areas of South Carolina meet or "attain" all national ambient air quality standards, including the 1-hour ozone standard. However, when implemented, the 8-hour ozone standard could result in numerous areas of the state being determined not to meet the 8-hour standard and being designated as "non-attainment" for ground-level ozone. In South Carolina, 18 of 23 ozone monitors, particularly those in the more populated urban areas, regularly exceed the 8-hour standard. When air quality standards are revised, the state must recommend to EPA the boundaries of the areas that are not in compliance with the standard and must submit a plan to EPA that demonstrates how the state will bring those areas designated as non-attainment for the standard back into attainment. EPA will make the 8-hour ozone non-attainment designations by April 15, 2004, with input from the Department.

When EPA designates areas as non-attainment, these areas automatically become subject to additional permitting requirements referred to as non-attainment new source review and complex transportation planning requirements referred to as transportation conformity. In an effort to be proactive and bring cleaner air sooner to the citizens of South Carolina, the Department, with EPA support, has begun the process with state and local governments, industry, environmental groups, and other interested parties to consider possible ozone reduction strategies. The Department has been working with these stakeholder groups over the last year to develop strategies sooner than would be required by the current federal timeframes to reduce the pollution that creates ground-level ozone.

This strategy of bringing cleaner air to the state sooner than would be required under the current federal timeframes is referred to as the Early Action Compact or EAC. In accordance with the EAC, EPA has laid out specific milestones that the state must meet to reduce ozone precursors so that our ozone monitors will be attaining the 8-hour standard by 2007 and beyond. Aside from the public health benefits realized by meeting the new standard sooner than required, another reason for embarking on this approach is that if we are successful, EPA will defer the effective date of the non-attainment designations.

The purpose of the regulations is to reduce or regulate the growth of ozone precursors so that the ozone monitors in the state are attaining the ozone standard in 2007 and to ensure that the Department is meeting the milestones specified by EPA for the EAC process. As part of the EAC process, the Department has promulgated a new regulation, R.61-62.5, Standard 5.2, *Control of Oxides of Nitrogen* (NO_x). In addition, the Department has revised R.61-62.5, Standard 5.1, *Lowest Achievable Emission Rate (LAER) Applicable to Volatile Organic Compounds,* and R.61-62.2, *Prohibition of Open Burning.*

Discussion of Revisions:

SECTION CITATION: EXPLANATION OF CHANGE

R.61-62.5, STANDARD 5.2, CONTROL OF OXIDES OF NITROGEN (NOX)

A new regulation has been added.

R.61-62.5, STANDARD 5.1, LOWEST ACHIEVABLE EMISSION RATE (LAER) APPLICABLE TO VOLATILE ORGANIC COMPOUNDS

Regulation title	The title of the regulation has been changed to *Best Available Control Technology (BACT)/Lowest Achievable Emission Rate (LAER) Applicable to Volatile Organic Compounds*.
Section I (A)(3)	The definition of "actual emissions" has been revised.
Section I (C)	A new definition has been added for "Best Available Control Technology (BACT)."
Section II (A)	The paragraph has been revised to indicate that new construction permits issued after the effective date of this regulation shall apply BACT.
Section II (B)	A new paragraph has been added to specify that, if the Department determines that the application of BACT/LAER controls would result in the emission of pollutants which might cause or significantly contribute to an exceedance of an ambient air quality standard, a lesser degree of control may be allowed.

R.61-62.2, PROHIBITION OF OPEN BURNING

Section I (C)	The paragraph has been revised to clarify that only clean wood products shall be used for fires set for human warmth.
Section I (D)	The paragraph has been revised for clarity.
Section I (E)	The paragraph has been deleted
Section I (F)	The paragraph has been deleted.
Section I (G)	The paragraph has been renumbered as Section I(E) and revised to stipulate that material to be burned must be generated onsite.
Section I (H)	The paragraph has been renumbered as Section I(F) and revised to specify that only permanent fire-fighter training facilities are exempt and that non-permanent locations must receive Department approval prior to any burning activity.
Section I (I)	The paragraph allowing the burning of household trash on the premises of and originating from private residences has been deleted.
Section I (J)	The paragraph has been renumbered as Section I(G) and revised to allow only residential construction waste to be burned in accordance with the provisions specified in the regulations.

Section I (K)	The paragraph has been renumbered as Section I(H) and revised for clarity and renumbered.

Instructions:

Add to R.61-62 new R.61-62.5, Standard 5.2, *Control of Oxides of Nitrogen (NOx)*.
Replace in entirety existing R.61-62.5, Standard 5.1,*Lowest Achievable Emission Rate (LAER) Applicable to Volatile Organic Compounds,* with this amendment.
Replace in entirety existing R.61-62.2, *Prohibition of Open Burning,* with this amendment.

Add R.61-62.5, Standard 5.2, *Control of Oxides of Nitrogen (NOx)* to read:

SOUTH CAROLINA
DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

AIR POLLUTION CONTROL REGULATIONS AND STANDARDS

REGULATION 61-62. 5
AIR POLLUTION CONTROL STANDARDS

STANDARD NO. 5.2
CONTROL OF OXIDES OF NITROGEN (NOx)

SECTION I - APPLICABILITY

(a) Except as provided in paragraph (b) of this part, the provisions of this regulation shall apply to any stationary source that emits or has the potential to emit oxides of nitrogen (NOx) generated from fuel combustion that has not undergone a Best Available Control Technology (BACT) analysis for NOx in accordance with SC Regulation 61-62.5, Standard No. 7 and that meets one or more of the criteria specified in paragraphs (a)(1), (a)(2), and (a)(3) of this part:

(1) Any new source that is permitted to construct after the effective date of this regulation;

(2) Any existing source where a burner assembly is replaced with another burner assembly after the effective date of this regulation, regardless of size or age of the burner assembly to be replaced. The replacement of individual components such as burner heads, nozzles, or windboxes does not trigger the applicability of this regulation; or

(3) Any existing source that is removed from its presently permitted facility and moved to another permitted facility after the effective date of this regulation except process equipment and commercial or industrial boilers that are transferred between facilities within the state under common ownership. Such transfers will be considered as existing sources under (a)(2) above.

(b) Exemptions:

The following sources are exempt from all requirements of this regulation unless otherwise specified:

(1) Any source less than 10×10^6 BTU/HR rated input capacity that burns a fuel.

(2) Emergency power generators of less than 150 KW rated capacity, or those that operate 250 hours per year or less and have a method to record the actual hours of use such as an hour meter.

(3) Any internal combustion engine with a mechanical power output of less than 200 bHP.

(4) Any device functioning solely as a combustion control device.

(5) Any equipment that has NOx controls pursuant to the requirements 40 CFR Parts 60, 61, or 63 where such controls are equivalent to, or more stringent than, the requirements of this regulation.

(6) Any source that has NOx controls pursuant to the requirements of SC Regulation 61-62.96, where such controls are equivalent to, or more stringent than, the requirements of this regulation.

(7) Any source that has NOx controls pursuant to the requirements of SC Regulation 61-62.99.

(8) Flares

(9) Air Curtain Incinerators

(10) Fuel Cell Sources

(11) Engines test cells/stands

(12) Portable and temporary IC engines such as those associated with generators, air compressors, or other applications provided that they fall in the categories listed in 40 CFR 89, *Control of Emissions from New and In-Use Nonroad Compression-Ignition Engines*.

(13) Combustion sources that operate at a capacity of less than 10% per year.

(14) Special use burners, such as start-up/shut-down burners, that are operated less than 500 hours a year.

(15) Liquor guns on a recovery boiler are only exempt from the standard requirements in Section IV.

(16) Portable sources such as asphalt plants or concrete batch plants are only exempt from the standard requirements in Section III.

(17) The Department reserves the right to consider any other exemptions from this regulation on a case-by-case basis as appropriate.

SECTION II - DEFINITIONS

For the purposes of this regulation, the following definitions shall apply:

Burner Assembly: Means any complete, pre-engineered device that combines air (or oxygen) and fuel in a controlled manner and admits this mixture into a combustion chamber in such a way as to ensure safe and efficient combustion. A self-contained chamber such as is found on a combustion turbine is not a burner assembly for the purposes of this regulation.

Case-by-Case NOx Control: Means an emissions limitation based on the maximum degree of reduction for NOx which would be emitted from any new source which the Department, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source through application of production processes or available methods, systems, and techniques. In no event shall application of NOx control result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard. If the Department determines that technological or economic limitations on the application of measurement methodology to a particular source would make the impositions of an emission standard infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of NOx control. Such standard shall, to the degree possible, set forth the emissions reduction achievable by implementation of such design, equipment, work practice or operation, and shall provide for compliance by means, which achieve equivalent results.

Combustion Control Device: Means, but is not limited to, any equipment that is used to destroy or remove air pollutant(s) prior to discharge to the atmosphere, excluding boilers, process heaters, dryers, furnaces, digesters, ovens, combustors, and similar combustion devices. Such equipment includes, but is not limited to, thermal oxidizers, catalytic oxidizers, and flares.

Constructed: Means the on-site fabrication, erection, or installation of the NOx emitting source.

Fuel: Means the following or any combination of the following: virgin fuel, fossil fuel, waste, waste fuel, biomass fuel, biofuel, methanol, ethanol, biodiesel, landfill gas, digester gas, process liquid or gas, or any combustible material the Department determines to be a fuel.

Source: Means an individual NOx emission unit.

Tune-up: Means adjustments made to the combustion process to optimize combustion efficiency of the source in accordance with procedures provided by the manufacturer or in accordance with good engineering practices.

SECTION III – STANDARD REQUIREMENTS FOR NEW SOURCES

(a) Those sources as defined in Section I (a)(1) and (a)(3) shall apply NOx controls capable of achieving the limitations provided in Table 1 of this section. Unless otherwise noted, all emission limits identified in Table 1 are based on monthly averages.

(b) A source may request an alternate control limitation by submitting a demonstration that the alternate limitation is a Case-by-Case NOx Control as defined in Section II.

(c) The Department reserves the right to request that the owner or operator submit additional information for those sources that request alternate control limitation in accordance with Section III (b) above.

(d) Sources required to install post combustion technology for the control of NOx, shall be required to use post combustion for the control of NOx during the ozone season (April 1 through October 31).

Table 1 - NOx Control Standards

Source Type	Control Technology and/or Emission Limit

Boilers and Water Heaters	
Natural Gas Fired Boilers	
$\geq$10mmBTU/hr and < 100mmBTU/hr	Low NOx Burners or equivalent technology capable of achieving 30ppmv @ 3% O2 Dry (0.036 lb/mmBTU)
$\geq$100mmBTU/hr	Low NOx Burners + Flue Gas Recirculation or equivalent technology capable of achieving 30 ppmv @ 3% O2 Dry (0.036 lb/mmBTU)
Distillate Oil Fired Boilers	
$\geq$10mmBTU/hr and < 100mmBTU/hr	Low NOx Burners or equivalent technology capable of achieving 0.15 lb/mmBTU
$\geq$100mmBTU/hr	Low NOx Burners + Flue Gas Recirculation or equivalent technology capable of achieving 0.14 lb/mmBTU
Residual Oil Fired Boilers	
$\geq$10mmBTU/hr and < 100mmBTU/hr	Low NOx Burners or equivalent technology capable of achieving 0.3 lb/mmBTU
$\geq$100mmBTU/hr	Low NOx Burners + Flue Gas Recirculation or equivalent technology capable of achieving 0.3 lb/mmBTU
Multiple Fuel Boilers	The emission limits for boilers burning multiple fuels are calculated in accordance with the formulas below. Additional fuels shall be addressed on a case-by-case basis.
$\geq$10mmBTU/hr and < 100mmBTU/hr	E_n = [(0.036 lb/mmBTU H_{ng}) + (0.15 lb/mmBTU H_{do}) + (0.3 lb/mmBTU H_{ro}) + (0.35 lb/mmBTU H_c) + (0.2 lb/mmBTU H_w)]/(H_{ng} + H_{do}+ H_{ro} + H_c + H_w) where: E_n is the nitrogen oxides emission limit (expressed as NO_2), ng/J (lb/million Btu) H_{ng} is the heat input from combustion of natural gas, H_{do} is the heat input from combustion of distillate oil H_{ro} is the heat input from combustion of residual oil, H_c is the heat input from combustion of coal, H_w is the heat input from combustion of wood residue.
$\geq$100mmBTU/hr	E_n = [(0.036 lb/mmBTU H_{ng}) + (0.14 lb/mmBTU H_{do}) + (0.3 lb/mmBTU H_{ro}) + (0.25 lb/mmBTU H_c) + (0.2 lb/mmBTU

	$H_w)]/(H_{ng} + H_{do} + H_{ro} + H_c + H_w)$ where: E_n is the nitrogen oxides emission limit (expressed as NO_2), ng/J (lb/million Btu) H_{ng} is the heat input from combustion of natural gas, H_{do} is the heat input from combustion of distillate oil H_{ro} is the heat input from combustion of residual oil, H_c is the heat input from combustion of coal. H_w is the heat input from combustion of wood residue.
Wood Residue Boilers	
All types	Combustion controls to minimize NOx emissions or equivalent technology capable of achieving 0.20 lb/mmBTU
Coal Fired Stoker Fed Boilers	
< 250 mmBTU/hr	Combustion controls to minimize NOx emissions or equivalent technology capable of achieving 0.35 lb/mmBTU
≥ 250 mmBTU/hr	Combustion controls to minimize NOx emissions or equivalent technology capable of achieving 0.25 lb/mmBTU
Pulverized Coal Fired Boilers	
< 250 mmBTU/hr	Low NOx Burners + Combustion controls to minimize NOx emissions or equivalent technology capable of achieving 0.35 lb/mmBTU
≥ 250 mmBTU/hr	Low NOx Burners + Combustion controls to minimize NOx emissions + SCR or equivalent technology capable of achieving 0.14 lb/mmBTU
Municipal refuse fired boilers	
< 250 mmBTU/hr	Combustion modifications to minimize NOx emissions + Flue Gas Recirculation or equivalent technology capable of achieving 200 ppmv @12% CO_2 (0.35 lb/mmBTU)
≥ 250 mmBTU/hr	Staged Combustion and Automatic Combustion Air Control + SCR or equivalent technology capable of achieving 0.18 lb/mmBTU
Internal Combustion Engines	
Compression Ignition	Timing Retard ≤ 4^o + Turbocharger w/ Intercooler or equivalent technology capable of achieving 490 ppmv @ 15% O_2 (7.64 gm/bhp-hr)

Spark Ignition	Lean Burn Technology or equivalent technology capable of Achieving 1.0 gm/bhp-hr
Landfill or Digester Gas Fired	Lean Burn Technology or equivalent technology capable of Achieving 1.25 gm/bhp-hr
Gas Turbines	
Simple Cycle – Natural Gas	
< 50 Megawatts	Combustion Modifications (e.g. dry low-NOx combustors) to minimize NOx emissions or equivalent technology capable of achieving 25 ppmv @ 15% O_2 Dry (0.054 lb/mmBTU)
≥ 50 Megawatts	Combustion Modifications (e.g. dry low-NOx combustors) to minimize NOx emissions or equivalent technology capable of achieving 9.0 ppmv @ 15% O_2 Dry (0.033 lb/mmBTU)
Combined Cycle – Natural Gas	
< 50 Megawatts	Dry Low-NOx Combustors or equivalent technology capable of achieving 9.0 ppmv @ 15% O_2 Dry (0.033 lb/mmBTU)
≥ 50 Megawatts	Dry Low-NOx Combustors + SCR or equivalent technology Capable of achieving 3.0 ppmv @ 15% O_2 Dry (0.011lb/mmBTU)
Simple Cycle – Distallate Oil Combustion	
< 50 Megawatts	Combustion Modifications and water injection to minimize NOx emissions or equivalent technology capable of achieving 42 ppmv @ 15% O_2 Dry Basis (0.16 lb/mmBTU)
≥ 50 Megawatts	Combustion Modifications and water injection to minimize NOx emissions or equivalent technology capable of achieving 42 ppmv @ 15% O_2 Dry Basis (0.16 lb/mmBTU)
Combined Cycle - Distillate oil combustion	
< 50 Megawatts	Dry Low-NOx Combustors with water injection, or equivalent technology capable of achieving 42 ppmv @ 15% O_2 Dry Basis (0.16 lb/mmBTU)
≥ 50 Megawatts	Dry Low-NOx Combustors, water injection, and SCR or Equivalent technology capable of achieving 10 ppmv @ 15% O_2 Dry Basis (0.038 lb/mmBTU)
Landfill Gas Fired	Water or steam injection or low NOx turbine design or equivalent

	technology capable of achieving 25 ppmv @ 15% O_2 (0.097 lb/mmBTU)
Cement Kilns Low NOx burners or equivalent technology capable of achieving 30% reduction from uncontrolled levels.	
Fluidized Bed Combustion (FBC) Boiler:	
Coal Fired	SNCR- Urea (Selective Noncatalytic Reduction - Urea) capable of achieving 51.8 ppm @ 3% oxygen (0.07 lbs/mmBTU)
Wood Fired	SNCR- Urea (Selective Noncatalytic Reduction - Urea) capable of achieving 51.8 ppm @ 3% oxygen (0.07 lbs/mmBTU)
Recovery Furnaces 4^{th} level or air to recovery furnace/good combustion practices or equivalent technology capable of achieving 100 ppm @8% oxygen	
Lime Kilns Combustion controls or equivalent technology capable of achieving 175 ppm @ 10% oxygen	
Fuel Combustion Sources Not Otherwise Specified: (Examples include but are not limited to process heaters, dryers, furnaces, ovens, duct burners, incinerators, and smelters) Low NOx burners or equivalent technology capable of achieving 30% reduction from uncontrolled levels.	

SECTION IV - STANDARD REQUIREMENTS FOR EXISTING SOURCES

(a) For those sources subject to the requirements of this regulation as defined in Section I (a)(2) above where an existing burner assembly is replaced after the effective date of this regulation, the burner assembly shall be replaced with a low NOx burner assembly or equivalent technology capable of achieving a 30 percent reduction from uncontrolled NOx emission levels based upon manufacturer's specifications. An exemption from this requirement shall be granted when a single burner assembly is being replaced in a source with multiple burners due to non-routine maintenance.

(b) For those sources defined in Section I (a)(2) above where an existing burner assembly is replaced after the effective date of this regulation, the owner or operator shall notify and register the replacement with the Department in accordance with Section V below.

(c) A facility may request an alternative control methodology to the one specified in paragraph (a) of this section provided that they can demonstrate to the Department why the NOx control limits specified are not economically or technically feasible for this specific circumstance. The Department reserves the right to request that the owner or operator submit additional information as necessary for the alternative control methodology determination. Alternative control methodologies granted under this part are not effective until notification is submitted to and approved by the Department.

SECTION V – NOTIFICATION REQUIREMENTS

(a) Except for those sources that wish to request an alternative control methodology as specified in Section IV(c), the notification requirements specified in this section shall apply only to existing sources as defined in Section I(a)(2) above where an existing burner assembly is replaced after the effective date of this regulation.

(b) Within 7 days of replacing an existing burner assembly, the owner or operator shall submit written notification to register the replacement unit with the Department.

(c) Notification shall satisfy the permitting requirements consistent with SC Regulation 61-62.1, Section II (a).

(d) Notification shall contain replacement unit information as requested in the format provided by the Department. Replacement unit information shall include, at a minimum, all affected units at the source and the date the replacement unit(s) will commence operation.

(e) Those sources that wish to receive an emission reduction credit for the control device will be required to submit a permit application.

SECTION VI – TUNE-UP REQUIREMENTS

(a) Owners or operators of a combustion source shall perform tune-ups every two years in accordance with manufacturer's specifications or with good engineering practices.

(b) All tune-up records are required to be maintained on site and available for inspection by the Department for a period of five years from the date generated.

(c) The facility shall develop and retain a tune-up plan on file.

Replace Regulation 61-62.5, Standard 5.1 in entirety, to read as follows:

SOUTH CAROLINA
DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

AIR POLLUTION CONTROL REGULATIONS AND STANDARDS

REGULATION 61-62.5
AIR POLLUTION CONTROL STANDARDS

STANDARD NO. 5.1

BEST AVAILABLE CONTROL TECHNOLOGY (BACT)/
LOWEST ACHIEVABLE EMISSION RATE ("LAER")
APPLICABLE TO VOLATILE ORGANIC COMPOUNDS

SECTION I - DEFINITIONS

A. "Net VOC Emissions Increase" means the amount by which the sum of the following exceeds zero:

1. Any actual increase in the emissions of VOCs from a particular physical change or change in method of operation at a plant; and

2. Any other increases and decreases in the actual VOC emissions at the plant that occurred at the plant since July 1, 1979, and are otherwise creditable. An increase or decrease is creditable only if the Department has not relied on it in issuing a permit for the plant under this Standard, which permit is in effect when the increase from the particular change occurs.

3. "Actual emissions" means the actual rate of emissions of a pollutant from an emissions unit, as determined in accordance with paragraphs (a) through (c) below.

(a) In general, actual emissions as of a particular date shall equal the average rate, in tons per year, at which the unit actually emitted the pollutant during a two-year period which preceded the particular date and which is representative of normal source operation. The Department may allow the use of a different time period upon a determination that it is more representative of normal source operation. Actual emissions shall be calculated using the unit's actual operating hours, production rates, and types of materials processed, stored, or combusted during the selected time period.

(b) The Department may presume that source-specific allowable emissions for the unit are equivalent to the actual emissions of the unit.

(c) For any emissions unit which has not begun normal operations on the particular date, actual emissions shall equal the potential to emit of the unit on that date.

B. Lowest Achievable Emission Rate (LAER) means that rate of emissions based on the following, whichever is more stringent:

1. The most stringent emission limitation which is contained in the State Implementation Plan of any state for such class or category of source, unless the owner or operator of the proposed source demonstrates that such limitations are not achievable; or

2. The most stringent emission limitation which has been achieved in practice by such class or category of source.

In no event shall the application of LAER permit a proposed new or modified source to emit any pollutant in excess of the amount allowable under New Source Performance Standards if applicable.

C. Best Available Control Technology (BACT) means an emissions limitation based on the maximum degree of reduction for VOC which would be emitted from any proposed physical change or change in method of operation which the Department, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques. In no event shall application of best available control technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 40 CFR parts 60 and 61. If the Department determines that technological or economic limitations on the application of measurement methodology to a particular emissions unit would make the impositions of an emissions standard infeasible, a design, equipment, work practice, operational standard, or combination thereof, may be prescribed instead to satisfy the requirement for the application of best available control technology. Such standard shall, to the degree possible, set forth the emissions reduction achievable by implementation of such design, equipment, work practice or operation, and shall provide for compliance by means, which achieve equivalent results.

SECTION II - GENERAL APPLICABILITY

A. This standard shall apply to all new, modified, or altered sources that would increase emissions of Volatile Organic Compounds (VOC). Lowest Achievable Emission Rate shall be applied to construction or modifications permitted before (effective date published in *State Register*) when the net VOC emissions increase exceeds 100 tons per year. Best Available Control Technology shall be applied to any new construction permit issued on or after (effective date published in the *State Register*) when the net VOC emissions increase exceeds 100 tons per year.

B. The Department may allow a lesser degree of control, provided that such a determination does not supersede any other State or Federal requirements, if the Department determines that the application of BACT/LAER controls would result in the emission of pollutants which might cause or significantly contribute to an exceedance of an ambient air quality standard.

SECTION III - VOLATILE ORGANIC COMPOUND COMPLIANCE TESTING

The owner or operator of any volatile organic compound source required to comply with this Standard shall, at his own expense, conduct source tests in accordance with the provisions of R.61-62.1, Section IV, Source Tests, to demonstrate compliance unless the Department determines that the compliance status of the source can be monitored as described in Section IV, below.

If tests are required, the following conditions shall apply:

A. Test frequencies for VOC abatement equipment will be as follows:

1. every four (4) years for sources utilizing solvent recovery emission control devices (e.g. carbon adsorption, refrigeration). However, if fouling of the carbon bed is suspected in the case of carbon adsorption, more frequent test schedules can be required.

2. every two (2) years for sources utilizing catalytic incineration/destruction.

3. every four (4) years for sources utilizing flame incineration provided the source operates, calibrates, and maintains a recorder for each incinerator which continuously records the combustion zone temperature and such temperature is maintained at a value no less than that recorded during the last source test during which compliance was verified.

B. Testing of VOC capture systems will be performed annually. However, only an initial test will be required provided:

1. capture system flow rate indicators (e.g. magnehelic gauges, manometers) are operated, calibrated, and maintained, and

2. the indicated values are maintained at a level no less than that recorded during the last source test during which compliance was verified, and

3. the type and location of the flow rate indicators are approved by this Department, and

4. no process, capture system, or VOC abatement equipment modifications have been made.

C. Other sources will be placed on a two (2) year test cycle.

SECTION IV - RECORDKEEPING, REPORTING, MONITORING

A. The owner or operator of any VOC emission source or control equipment shall maintain, as a minimum: records of all compliance testing conducted under Section III above, and records of all monitoring conducted under paragraphs C.1. and C.2. below.

B. The owner or operator of any applicable VOC emission source or control equipment shall, on request, make available to the Department, or U.S. EPA, reports detailing the nature, specific sources, and total quantities of all VOC emissions for any specified period. Records must be kept which are consistent with the compliance time frames for each source subject to this standard.

C. The owner or operator of any VOC emission source or control equipment shall:

1. install, operate, calibrate and maintain process and/or control equipment, monitoring instruments, or procedures as required to comply with paragraphs A. and B. above; and,

2. maintain, in writing, data and/or reports relating to monitoring instruments or procedures which shall, upon review, document the compliance status of the VOC emission source or control equipment to the satisfaction of the Department.

D. Copies of all records and reports under paragraphs A., B., and C. above, shall be retained by the owner or operator for two years after the date on which the record was made or the reports submitted.

E. Copies of all records and reports required under this Section shall be available for inspection during normal working hours and furthermore, copies of the required records and reports shall be furnished within ten working days after receipt of a written request from the Department.

Replace Regulation 61-62.2 in its entirety to read as follows:

SOUTH CAROLINA
DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

AIR POLLUTION CONTROL REGULATIONS AND STANDARDS

REGULATION 61-62.2
PROHIBITION OF OPEN BURNING

OPEN BURNING IS PROHIBITED EXCEPT AS PROVIDED BELOW:

SECTION I - Exceptions

A. Open burning of leaves, tree branches or yard trimmings originating on the premises of private residences and burned on those premises.

B. Open burning in connection with the preparation of food for immediate consumption.

C. Campfires and fires used solely for recreational purposes, ceremonial occasions, or human warmth. Fires set for the purpose of human warmth must use only clean wood products (woody vegetation, leaves, or wood which is not coated with stain, paint, glue or other coating material, and not treated lumber).

D. Fires purposely set in accordance with *Smoke Management Guidelines for Vegetative Debris Burning Operations in South Carolina*, administered by the South Carolina Forestry Commission and acceptable to the Department to include the following:

1. Prescribed burning of forest lands for specific management practices; and

2. Fires purposely set for agricultural control of diseases, weeds, pests, and for other specific agricultural purposes.

3. Open burning of trees, brush, grass and other vegetable matter for game management purposes.

E. Open burning in areas other than predominantly residential for the purpose of land clearing or right-of-way maintenance. This will be exempt only if the following minimum conditions are followed:

1. The location of the burning must be a sufficient distance but not less than 1000 feet, from public roadways and all residential, commercial, and industrial sites not a part of the contiguous property on which the burning is conducted.

2. Winds during the time of the burning must be away from any area in which the ambient air may be significantly affected by smoke from the burning if that area contains a public roadway or a residential, commercial, or industrial site.

3. The material to be burned must have been generated onsite and not moved to the site from another location;

4. The amount of dirt on the material being burned must be minimized;

5. No heavy oils, asphaltic materials, items containing natural or synthetic rubber, or any materials other than plant growth may be burned;

6. The initial burning must be started only between the hours of 9:00 a.m. and 3:00 p.m.; no combustible material may be added to the fire between 3:00 p.m. of one day and 9:00 a.m. the following day;

7. No more than two piles 30' x 30' or equivalent may be burned within a six-acre area at one time; and

8. In the case of land clearing, all salvageable timber and pulpwood must be removed.

F. Fires set for the purposes of training fire-fighting personnel and conducted at permanent fire-fighter training facilities. Prior Department approval is required in order to obtain the exemption as a permanently established training site. Fires set for the purpose of fire-fighter training at non-permanent locations must receive Department approval prior to the initiation of any burning activity. Materials used for fire-fighter training cannot contain asbestos, heavy oils, asphaltic material, plastic or rubber without express written consent from the Department.

G. Open burning on the property where it occurs of residential construction waste from building and construction operations will be exempt only if the following conditions are met:

1. The material being burned is residential construction waste associated with the building and construction of one and two family dwellings only;

2. The location of the burning is at least five hundred (500) feet from any occupied structure other than a dwelling or structure located on the property on which the burning is conducted;

3. Heavy oils, treated wood products, asphaltic materials, items containing natural or synthetic rubber, or any other trade wastes which produce smoke in excess of forty (40) percent opacity are not burned;

4. The burning does not occur during the ozone season (April 1 through October 30); and

5. The burning is conducted only between the hours of 9:00 a.m. and 3:00 p.m.;

H. Open burning, in remote or specified areas~~:~~

1. For non-recurring unusual circumstances.

2. For experimental burning for purposes of data gathering and research.

However, prior approval for these types of burning (in subparagraph H above) must be obtained from the Department.

SECTION II - General

A. A written report or warning to a person of a violation at one site shall be considered adequate notice of the Regulation and subsequent observed violations at the same or different site will result in appropriate legal action.

B. Open burning may be conducted in certain situations if no undesirable levels are or will be created. The authority to conduct open burning under this Regulation does not exempt or excuse the person responsible for the burning from the consequences of or the damages or injuries resulting from the burning and does not exempt or excuse anyone from complying with other applicable laws and with ordinances, regulations, and orders of governmental entities having jurisdiction, even though the burning is otherwise conducted in compliance with this Regulation.

C. The Department reserves the right to impose other or different restrictions and exemptions on open burning in addition to those enumerated above, whenever in the judgment of the Department such is necessary to realize the purpose of this Regulation.

Fiscal Impact Statement:

The Department estimates no additional cost will be incurred by the state or its political subdivisions as a result of the promulgation, approval, and implementation of this amendment.

Statement of Need and Reasonableness:

This statement of need and reasonableness was determined by staff analysis pursuant to S.C. Code Section 1-23-115(C)(1)-(3) and (9)-(11).

DESCRIPTION OF REGULATION:

Purpose: On July 18, 1997, the United States Environmental Protection Agency (EPA) revised the National Ambient Air Quality Standard for ground-level ozone from 0.12 parts per million (ppm) 1-hour "peak" standard to 0.08 ppm 8-hour "average" standard. The National Ambient Air Quality Standards are health-based standards established at levels intended to protect public health. This "new" ozone standard is commonly referred to as the 8-hour ozone standard. Currently, all areas of South Carolina meet or "attain" all national ambient air quality standards, including the 1-hour ozone standard. However, when implemented, the 8-hour ozone standard could result in numerous areas of the state being determined not to meet the 8-hour standard and being designated as "non-attainment" for ground-level ozone. In South Carolina, 18 of 23 ozone monitors, particularly those in the more populated urban areas, regularly exceed the 8-hour standard. When air quality standards are revised, the state must recommend to EPA the boundaries of the areas that are not in compliance with the standard and must submit a plan to EPA that demonstrates how the state will bring those areas designated as non-attainment for the standard back into attainment. EPA will make the 8-hour ozone non-attainment designations by April 15, 2004, with input from the Department.

When EPA designates areas as non-attainment, these areas automatically become subject to additional permitting requirements referred to as non-attainment new source review and complex transportation planning requirements referred to as transportation conformity. In an effort to be proactive and bring cleaner air sooner to the citizens of South Carolina, the Department, with EPA support, has begun the process with state and local governments, industry, environmental groups, and other interested parties to consider possible ozone reduction strategies. The Department has been working with these stakeholder groups over the last year to develop strategies sooner than would be required by the current federal timeframes to reduce the pollution that creates ground-level ozone.

This strategy of bringing cleaner air to the state sooner than would be required under the current federal timeframes is referred to as the Early Action Compact or EAC. In accordance with the EAC, EPA has laid out specific milestones that the state must meet to reduce ozone precursors so that our ozone monitors will be attaining the 8-hour standard by 2007 and beyond. Aside from the public health benefits realized by meeting the new standard sooner than required, another reason for embarking on this approach is that if we are successful, EPA will defer the effective date of the non-attainment designations.

The purpose of the proposed regulations is to reduce or regulate the growth of ozone precursors so that the ozone monitors in the state are attaining the ozone standard in 2007 and to ensure that the Department is meeting the milestones specified by EPA for the EAC process. As part of the EAC process, the Department is proposing to promulgate a new regulation, R.61-62.5, Standard 5.2, *Control of Oxides of Nitrogen (NO_x)*. In addition, the Department proposes to revise regulation 61-62.5, Standard 5.1, *Lowest Achievable Emission Rate (LAER) Applicable to Volatile Organic Compounds,* and regulation 61-62.2, *Prohibition of Open Burning.* Finally, the South Carolina State Implementation Plan (SIP) will be amended.

Legal Authority: The legal authority for regulation 61-62 is Sections 48-1-10 et seq., S.C. Code of Laws.

Plan for Implementation: The proposed amendments will take effect upon approval by the General Assembly and publication in the *State Register*. The proposed amendments will be implemented by providing the regulated community with copies of the regulation.

DETERMINATION OF NEED AND REASONABLENESS OF THE PROPOSED REGULATION BASED ON ALL FACTORS HEREIN AND EXPECTED BENEFITS:

As the national air quality standards are health-based standards, it is important that efforts are made to improve air quality to meet these standards as soon as possible. Further, when non-attainment designations occur, areas automatically become subject to new additional permitting requirements and complex transportation planning requirements. These prescriptive federal requirements represent a one-size-fits-all approach to reducing ozone pollution. They are an economic burden for areas with a non-attainment designation and may not be the best strategy for reducing ozone pollution in South Carolina. Furthermore, this approach encourages sprawl by penalizing sources that locate in non-attainment areas. The EAC approach ensures that we bring cleaner air sooner to the state by meeting the new ozone standard sooner than required under the current federal timeframes. In addition to the public health benefits, under the EAC process, EPA will defer of the effective date of the non-attainment designations and thereby allow us the opportunity to develop strategies better suited to South Carolina's needs.

DETERMINATION OF COSTS AND BENEFITS:

The economic impacts associated with non-attainment are significant. When an area is designated as non-attainment, new sources, or existing facilities in need of major modifications, must install the Lowest Achievable Emission Rate (LAER) technology. LAER does not allow economic costs to be considered when determining what pollution controls are to be installed. Thus, if the controls are technically feasible, they must be installed regardless of the costs. Furthermore, pollution offsets are required in non-attainment areas and this is an additional cost to be considered.

As a result of the expenses involved, new facilities will choose not to locate in non-attainment areas and will choose instead to locate outside the non-attainment boundary. This approach encourages sprawl by providing incentives for sources to locate outside of non-attainment areas. It also puts certain areas of the state at a significant economic disadvantage. This inequity is further compounded by the fact that air pollution knows no boundaries and thus, facilities can locate outside of the non-attainment area and still have emissions that negatively impact the non-attainment area's air quality.

The EAC approach requires that our monitors attain the 8-hour standard sooner than the current federal timeframes. This translates into cleaner air sooner for our citizens. There are obvious public health benefits to be derived from this approach that are hard to quantify. In addition, the EAC approach allows us to design our own strategy for attaining the 8-hour standard. The primary focus of the regulations the Department is proposing is to control the growth of emission of oxides of nitrogen (NOx). Proposed Regulation 61-62.5, Standard 5.2, *Control of Oxides of Nitrogen (NOx)*, requires reasonable NOx controls on fuel combustion sources. This regulation will ensure uniform controls across the state rather than the current federal system that requires stringent controls in select areas. Thus, in terms of a cost/benefit analysis for this regulation, we need to compare the stringent LAER and offsets that would occur in select areas of the state under a non-attainment designation with the more reasonable controls that would apply statewide as a result of these regulations. As an example of the cost differential, a new 125mmBTU/hr boiler under this regulation would be required to install low NOx burners capable of achieving 30 ppmv corrected to 3% O_2. According to vendor information and other sources, this technology would cost about $700 per ton of NOx reduced. If this same unit were installed in a non-attainment area, LAER for this unit would most likely be Selective Catalytic Reduction (SCR). A recent NESCAUM (The Northeast States for Coordinated Air Use Management) report estimates that the SCR on gas fired boilers is estimated to provide reductions for $2,000/ton for boilers of about 350mmBTU/hr that operate at high capacity factors. This number jumps to around $3,500/ton of NOx reduced for smaller, gas-fired boilers of a

100mmBTU/hr and this does not include the cost of offsets. Thus, it is evident that for non-attainment areas, the cost of controls under this regulation is significantly less than the costs would be if the area had a non-attainment designation.

Another regulation that the Department is revising in an effort to reduce NOx emissions statewide as part of the EAC process is Regulation 61-62.2, *Prohibition of Open Burning*. The most significant revisions to this regulation are as follows: deleting the exception for the burning of household trash, deleting the exception for the burning of construction waste, and revising the exception for fires set for the purpose of firefighter training. The burning of household trash and construction waste presents health and environmental concerns for many communities. The smoke generated from these activities is a nuisance to some and a health threat to others with asthma or other respiratory problems. Furthermore, the Department spends a lot of staff time and resources responding to complaints relating to these activities. The Department believes that deleting the exception for the burning of household trash will not result in any significant cost or hardship because other disposal options are readily available. With respect to the exception for the burning of construction waste, the Department is revising this provision to allow only residential construction waste to be burned and this will only be allowed if it meets the provisions of the regulation. Again, this is not expected to result in any significant cost or hardship because many other practical disposal options are available and most construction sites currently use other means of waste disposal. The Department is also proposing to revise the exceptions for the purposes of firefighter training to ensure consistency and to ensure that minimum health, environmental and safety concerns are addressed. The Department will do a review of permanent firefighter training facilities and will evaluate non-permanent sites and require Department approval prior to a burn. The Department does not anticipate that this will result in any significant costs because existing firefighter training facilities will not be adversely impacted and non-permanent sites will still be allowed, but held to consistent standards. This revision allows the Department to collect information and to grant prior approval for firefighter training sites.

Finally, the Department is proposing to revise Regulation 61-62.5, Standard 5.1, *Lowest Achievable Emission Rate (LAER) Applicable to Volatile Organic Compounds.* This regulation is being revised to require Best Available Control Technology (BACT) to be applied to any new construction permit issued after effective date of this revision when the net VOC emissions increase exceeds 100 tons per year. As stated above, LAER requires very stringent pollution controls regardless of costs. This revision will require BACT controls on new construction that results in a net VOC emissions increase of greater than 100 tons per year. This is consistent with the Department's proposed regulation for controlling NOx emissions which requires reasonable NOx controls on fuel combustion sources. The Department believes that less costly VOC controls that will result from this revision will further offset the costs to the regulated community of the NOx controls that the Department is proposing with Regulation 61-62.5, Standard 5.2, while still being protective of the environment and public health.

UNCERTAINTIES OF ESTIMATES:

Proposed Regulation 61-62.5, Standard 5.2, *Control of Oxides of Nitrogen (NOx)*, requires reasonable NOx controls on new, as well as some existing, fuel combustion sources. The cost of NOx controls will vary from source to source depending on size, fuel, and other factors. While the cost of this regulation will depend on the source in question, what is certain is that for sources locating in non-attainment areas, the costs will be far greater than the cost of the controls required by this regulation.

EFFECT ON ENVIRONMENT AND PUBLIC HEALTH:

The combination of these three regulations will have a positive impact on the environment and public health by reducing ozone pollution sooner than would be required under the federal timelines.

DETRIMENTAL EFFECT ON THE ENVIRONMENT AND PUBLIC HEALTH IF THE REGULATIONS ARE NOT IMPLEMENTED:
Ozone can irritate lung airways and cause inflammation much like a sunburn. Other symptoms include wheezing, coughing, pain when taking a deep breath, and breathing difficulties during exercise or outdoor activities. People with respiratory problems are most vulnerable, but even healthy people that are active outdoors can be affected when ozone levels are elevated. Repeated exposure to ozone pollution for several months may cause permanent lung damage. These regulations are designed to reduce ozone pollution sooner than would be required under the federal timelines. If these regulations are not implemented, the public health benefits will not be realized. Furthermore, if these regulations are not implemented, the state will fail to meet the EAC milestone and EPA will not defer the effective date of the non-attainment designations. This will encourage sprawl by providing incentives for sources to locate outside of non-attainment areas.

Statement of Rationale:

I. PURPOSE

S.C. Code of Laws Section 1-23-110(A)(3)(h) requires state agencies to prepare a detailed Statement of Rationale for all new regulations and significant amendments to existing regulations. This statement shall provide the basis for the regulation, including the scientific or technical basis, if any, and shall identify any studies, reports, policies, or statements of professional judgment or administrative need relied upon in developing the regulation. Accordingly, the SC Department of Health and Environmental Control (Department) has prepared the following Statement of Rationale for proposed amendments to Regulation 61-62, *Air Pollution Control Regulations and Standards*, to promulgate a new regulation, 61-62.5, Standard 5.2, *Control of Oxides of Nitrogen* (*NO_x*), and to revise regulation 61-62.5, Standard 5.1, *Lowest Achievable Emission Rate (LAER) Applicable to Volatile Organic Compounds*, and regulation 61-62.2, *Prohibition of Open Burning.*

II. INTRODUCTION

On July 18, 1997, the United States Environmental Protection Agency (EPA) revised the National Ambient Air Quality Standard for ground-level ozone from 0.12 parts per million (ppm) 1-hour "peak" standard to 0.08 ppm 8-hour "average" standard. This "new" ozone standard is commonly referred to as the 8-hour ozone standard. Currently, all areas of South Carolina meet or "attain" all national ambient air quality standards, including the 1-hour ozone standard. However, when implemented, the 8-hour ozone standard could result in numerous areas of the state being determined not to meet the 8-hour standard and being designated as "non-attainment" for ground-level ozone. In South Carolina, 18 of 23 ozone monitors, particularly those in the more populated urban areas, regularly exceed the 8-hour standard. When air quality standards are revised, the state must recommend to EPA the boundaries of the areas that are not in compliance with the standard and must submit a plan to EPA that demonstrates how the state will bring those areas designated as non-attainment for the standard back into attainment. EPA will make the 8-hour ozone non-attainment designations by April 15, 2004, with input from the Department.

When EPA designates areas as non-attainment, these areas automatically become subject to additional permitting requirements referred to as non-attainment new source review and complex transportation planning requirements referred to as transportation conformity. These prescriptive federal requirements represent a one-size-fits-all approach to reducing ozone pollution. They are an economic burden for areas with a non-attainment designation and may not be the best strategy for reducing ozone pollution in South Carolina.

EPA has recently outlined an alternative to the prescriptive federal requirements discussed above. This alternative process is referred to as the Early Action Compacts or EAC. The EAC approach represents a proactive approach to develop strategies sooner than would be required by the current federal timeframes to reduce the pollution that creates ground-level ozone. In accordance with the EAC, EPA has laid out specific milestones that the state must meet to reduce ozone precursors so that our ozone monitors will be attaining the 8-hour standard by 2007 and beyond. Aside from the public health benefits realized by meeting the new standard sooner than required, another reason for embarking on this approach is that if we are successful, EPA will defer the effective date of the non-attainment designations.

The purpose of the amendments that the Department is proposing is to reduce or regulate the growth of ozone precursors so that the ozone monitors in the state are attaining the ozone standard in 2007 and to ensure that the we are meeting the milestones specified by EPA for the EAC process. As part of the EAC process, the Department is proposing to promulgate a new regulation, R.61-62.5, Standard 5.2, *Control of Oxides of Nitrogen (NO_x)*. In addition, the Department proposes to revise regulation 61-62.5, Standard 5.1, *Lowest Achievable Emission Rate (LAER) Applicable to Volatile Organic Compounds,* and regulation 61-62.2, *Prohibition of Open Burning.* Finally, the South Carolina State Implementation Plan (SIP) will be amended.

This Statement of Rationale has been prepared to provide the basis for these regulations to include all reports and other studies that the Department has relied on in their development. As stated above, the Department is proposing to promulgate a new regulation and revise two existing regulations as part of the EAC process. Each regulation will be addressed separately below.

III. R.61-62.5, STANDARD 5.2, *CONTROL OF OXIDES OF NITROGEN (NO_X)*

The economic impacts associated with non-attainment are significant. When an area is designated as non-attainment, new sources, or existing facilities in need of major modifications, must install the Lowest Achievable Emission Rate (LAER) technology. LAER does not allow economic costs to be considered when determining what pollution controls are to be installed. Thus, if the controls are technically feasible, they must be installed regardless of the costs. Furthermore, pollution offsets are required in non-attainment areas and this is an additional cost to be considered.

The EAC approach requires that our monitors attain the 8-hour standard sooner than the current federal timeframes. This translates into cleaner air sooner for our citizens. There are obvious public health benefits to be derived from this approach that are hard to quantify. In addition, the EAC approach allows us to design our own strategy for attaining the 8-hour standard.

The primary focus of the Proposed Regulation 61-62.5, Standard 5.2, *Control of Oxides of Nitrogen (NOx)*, is to control the growth of emission of oxides of nitrogen (NOx). The regulation requires reasonable NOx controls on fuel combustion sources. This regulation will ensure uniform controls across the state rather than the current federal system that requires stringent controls in select areas. Accordingly, the Department is proposing controls on fuel combustion sources consistent with BACT determinations found in EPA's RACT/BACT/LAER Clearinghouse. The controls for specific equipment are provided below with a brief description on the reports or other documents that the Department has relied on to determine the costs of these controls.

1. Natural Gas Fired Boilers

Regulation 61-62.5, Standard 5.2, *Control of Oxides of Nitrogen (NO_x)* establishes a limit of 30 ppmv @ 3% O_2 Dry or 0.036 lb/mmbtu for natural gas fired boilers with heat inputs greater than or equal to 10mmbtu/hr. Low NO_x Burners (LNB) and Flue Gas Recirculation (FGR) as the presumptive controls for these boilers.

LNB reduce NO_x by accomplishing the combustion process in stages. Staging partially delays the combustion process, resulting in a cooler flame which suppresses thermal NO_x formation. The two most common types of LNB being applied to natural gas-fired boilers are staged air burners and staged fuel burners. NO_x emission reductions of 40 to 85 percent (relative to uncontrolled emission levels) have been observed with LNB.

The Western Regional Air Partnership (WRAP)[1] cites cost effectiveness of $200 – 1,000/ton at a 30 – 60% reduction of NO_x. In general, the capital costs for burners range from $10,000 to 50,000 per burner plus installation. The lower end of this range applies when existing burners are modified instead of replaced to achieve lower NO_x. Operating costs are negligible unless increased unburned carbon results in lost revenues from ash sales.

Complete Combustion Resources (CCR)[2] recently submitted a proposal for a 50 mmbtu gas/no.2 oil burner to meet 30ppm NO_x and <100ppm CO @ 3% O_2 for [an] industrial plant. This included removal of existing burner and controls, modifications to boiler, mounting, piping and wiring new burner, startup using Manufacturers Standard Performance and Emission testing. All freight and material cost[s] are included. Any additional stack testing that may be required by the state or EPA is not included. The price was $205,000.00. Existing burner was operating at approximately 160 – 180 ppm and operating at about 5% O_2. CCR[3] also states that a typical replacement burner on a boiler requiring 5 mmbtu input to fire natural gas costs about $12,000. Typical installation would be about $10,000. For Low NO_x burner to meet 30 ppm, the burner cost would be about $15,000 and the installation would be about $12,000. This typically includes all new burner, operating controls, burner management controls, fuel trains, boiler refractory and mounting plate modifications, minor electrical and startup.

According to Advanced Combustion Technology, Inc.[4] (ACT), typically all the burners on a boiler are replaced at the same time. Replacing just one (1) of several burners with a low NO_x type could lead to unbalanced combustion. In addition the overall NO_x impact of replacing one of the burners on a multi burner boiler would be slight. LNB[5] can achieve NO_x levels of 0.15 – 0.30 lb/mmbtu at a cost effectiveness of $300 - $500 per ton.

In a FGR system, a portion of the flue gas is recycled from the stack to the burner windbox. Upon entering the windbox, the recirculated gas is mixed with combustion air prior to being fed to the burner. The recycled flue gas consists of combustion products which act as inerts during combustion of the fuel/air mixture. The FGR system reduces NO_x formation by lowering the oxygen concentration in the primary flame zone. The amount of recirculated flue gas is a key operating parameter influencing NO_x emission rates for these systems. An FGR system is normally used in combination with specially designed LNB capable of sustaining a stable flame with the increased inert gas flow resulting from the use of FGR.

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[1] WRAP "Appendix C: NO_x Control Technology Summaries".
[2] E-mail from Neal Brooks, CCR to Heather Preston, SCDHEC dated September 2, 2003.
[3] E-mail from Neal Brooks, CCR to Heather Preston, SCDHEC dated June 6, 2003.
[4] E-mail from Roger Marx, ACT to Heather Preston, SCDHEC dated June 3, 2003.
[5] E-mail from Roger Marx, ACT to Heather Preston, SCDHEC dated June 9, 2003.

When LNB and FGR are used in combination, these techniques are capable of reducing NO_x emissions by 60 to 90 percent.

According to ACT, Single burner gas boilers can achieve 30ppm with upgraded LNB and FGR. The cost of this technology ranges from \$700 per ton for boiler sizes of 100 mmbtu/hr to \$1,500 per ton for the 5 mmbtu/hr case.[6] ACT[7] states that LNB and FGR can achieve NO_x levels of 0.04 – 0.08 lb/mmbtu at a cost effectiveness of \$400 - \$600 per ton. The Western Regional Air Partnership (WRAP) [8] cites cost effectiveness for flue gas recirculation (FGR) at \$500 – 3,000/ton at a 40 - 80% reduction of NO_x. The main cost from FGR on gas-fired sources involve the retrofit of the FGR fan(s) and required ductwork to route the flue gas to the burner front. Costs in the range of \$10 - \$20/kW are expected for power generation sources.

Distillate and Residual Oil Fired Boilers

One control technique for criteria pollutants from fuel oil combustion is combustion modification which includes any physical or operational change in the furnace or boiler and is applied primarily for NO_x control purposes, although for small units, some reduction in PM emissions may be available through improved combustion practice.

In boilers fired on crude oil or residual oil, the control of fuel NO_x is very important in achieving the desired degree of NO_x reduction since fuel NO_x typically accounts for 60 to 80 percent of the total NO_x formed. Fuel nitrogen conversion to NO_x is highly dependent on the fuel-to-air ratio in the combustion zone and, in contrast to thermal NO_x formation, is relatively insensitive to small changes in combustion zone temperature. In general, increased mixing of fuel and air increases nitrogen conversion which, in turn, increases fuel NO_x. Thus, to reduce fuel NO_x formation, the most common combustion modification technique is to suppress combustion air levels below the theoretical amount required for complete combustion. The lack of oxygen creates reducing conditions that, given sufficient time at high temperatures, cause volatile fuel nitrogen to convert to N_2 rather than NO.

Combustion controls reduce NO_x by suppressing NO_x formation during the combustion process. Combustion controls are the most widely used method of controlling NO_x formation in all types of boilers and include low-NO_x burners and flue gas recirculation.

Low NO_x Burners

Low NO_x burners are applicable to tangential and wall-fired boilers of various sizes. They have been used as a retrofit NO_x control for existing boilers and can achieve approximately 35 to 55 percent reduction from uncontrolled levels. They are also used in new boilers to meet NSPS limits. Low NO_x burners can be combined with overfire air to achieve even greater NOx reduction (40 to 60 percent reduction from uncontrolled levels).

WRAP[9] cites cost effectiveness of \$200 – 1,000/ton at a 30 – 60% reduction of NO_x. In general, the capital costs for burners range from \$10,000 to 50,000 per burner plus installation. The lower end of this

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[6] E-mail from Roger Marx, ACT to Heather Preston, SCDHEC dated June 3, 2003.
[7] E-mail from Roger Marx, ACT to Heather Preston, SCDHEC dated June 9, 2003.
[8] WRAP "Appendix C: NO_x Control Technology Summaries". www.wrapair.org/forums/mtf/documents/nox_pm/Section_VI_Appendices.doc
[9] WRAP "Appendix C: NO_x Control Technology Summaries". www.wrapair.org/forums/mtf/documents/nox_pm/Section_VI_Appendices.doc

range applies when existing burners are modified instead of replaced to achieve lower NO_x. Operating costs are negligible unless increased unburned carbon results in lost revenues from ash sales. ACT[10] states that LNB can achieve NO_x levels of 0.25 – 0.30 lb/mmbtu at a cost effectiveness of $300 - $500 per ton. CCR [11] states that a typical replacement burner on a boiler requiring 5 mmbtu input to fire number 2 fuel oil costs about $12,000. Typical installation would be about $10,000. For Low NO_x burner to meet 30 ppm, the burner cost would be about $15,000 and the installation would be about $12,000. This typically includes all new burner, operating controls, burner management controls, fuel trains, boiler refractory and mounting plate modifications, minor electrical and startup.

<u>Flue Gas Recirculation</u>

Flue gas recirculation involves extracting a portion of the flue gas from the economizer section or air heater outlet and readmitting it to the furnace through the furnace hopper, the burner windbox, or both. This method reduces the concentration of oxygen in the combustion zone and may reduce NO_x by as much as 40 to 50 percent in some boilers. Overfire air is a technique in which a percentage of the total combustion air is diverted from the burners and injected through ports above the top burner level. Overfire air limits NO_x by (1) suppressing thermal NO_x by partially delaying and extending the combustion process resulting in less intense combustion and cooler flame temperatures; (2) a reduced flame temperature that limits thermal NO_x formation, and/or (3) a reduced residence time at peak temperature which also limits thermal NO_x formation.

STAPPA/ALAPCO[12] cites cost effectiveness of FGR on a 50mmbtu/hr burner on a residual oil-fired boiler to be between $3530 and $7060 per mmbtu/hr. The same sized burner on a distillate oil-fired boiler has a cost effectiveness between $9780 and $19,600 per mmbtu/hr.

Bituminous and Subbituminous Coal Combustion

Combustion Controls

Combustion controls reduce NO_x by suppressing NO_x formation during the combustion process, while postcombustion controls reduce NO_x emission after their formation.

Low NO_x Burners

LNBs limit NO_x formation by controlling the stoichiometric and temperature profiles of the combustion process in each burner zone. The unique design of features of an LNB may create (1) a reduced oxygen level in the combustion zone to limit fuel NO_x formation, (2) a reduced flame temperature that limits thermal NO_x formation, and/or (3) a reduced residence time at peak temperature which also limits thermal NO_x formation.

LNBs are applicable to tangential and wall-fired boilers of various sizes but are not applicable to other boiler types such as cyclone furnaces or stokers. They have been used as a retrofit NO_x control for existing boilers and can achieve approximately 35 to 55 percent reduction from uncontrolled levels. They are also used in new boilers to meet New Source Performance Standards (NSPS) limits. LNBs can be combined with OFA to achieve even greater NO_x reduction (40 to 60 percent reduction from uncontrolled levels).

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[10] E-mail from Roger Marx, ACT to Heather Preston, SCDHEC dated June 9, 2003.
[11] E-mail from Neal Brooks, CCR to Heather Preston, SCDHEC dated June 6, 2003.
[12] Controlling Nitrogen Oxides Under the Clean Air Act: A Menu of Options. July 1994.

ACT[13] states that LNB and OFA can achieve NO_x levels of 0.28 – 0.35 lb/ mmbtu at a cost effectiveness of $400 - $700 per ton. ACT states that LNB can achieve NO_x levels of 0.40 – 0.45 lb/mmbtu at a cost effectiveness of $300 - $500 per ton. WRAP[14] cites cost effectiveness of $200 – 1,000/ton at a 30 – 60% reduction of NO_x. In general, the capital costs for burners range from $10,000 to 50,000 per burner plus installation. The lower end of this range applies when existing burners are modified instead of replaced to achieve lower NO_x. Operating costs are negligible unless increased unburned carbon results in lost revenues from ash sales.

Internal Combustion (IC) Engines

Control measures to date are primarily directed at limiting NO_x and CO emissions since they are the primary pollutants from these engines. From a NO_x control viewpoint, the most important distinction between different engine models and types of reciprocating engines is whether they are rich-burn or lean-burn. Rich-burn engines have an air-to-fuel ratio operating range that is near stoichiometric or fuel-rich of stoichiometric and as a result the exhaust gas has little or no excess oxygen. A lean-burn engine has an air-to-fuel operating range that is fuel-lean of stoichiometric; therefore, the exhaust from these engines is characterized by medium to high levels of O_2. The most common NO_x control technique for diesel and dual-fuel engines focuses on modifying the combustion process. However, selective catalytic reduction (SCR) and nonselective catalytic reduction (NSCR) which are post-combustion techniques are becoming available.

Combustion Controls

Combustion modifications include injection timing retard (ITR), preignition chamber combustion (PCC), air-to-fuel adjustments, and derating. Injection of fuel into the cylinder of a CI engine initiates the combustion process. Retarding the timing of the diesel fuel injection causes the combustion process to occur later in the power stroke when the piston is in the downward motion and combustion chamber volume is increasing. By increasing the volume, the combustion temperature and pressure are lowered, thereby lowering NO_x formation. ITR reduces NO_x from all diesel engines; however, the effectiveness is specific to each engine model. The amount of NO_x reduction with ITR diminishes with increasing levels of retard.

The air-to-fuel ratio for each cylinder can be adjusted by controlling the amount of fuel that enters each cylinder. At air-to-fuel ratios less than stoichiometric (fuel-rich), combustion occurs under conditions of insufficient oxygen which causes NO_x to decrease because of lower oxygen and lower temperatures. Derating involves restricting the engine operation to lower than normal levels of power production for the given application. Derating reduces cylinder pressures and temperatures, thereby lowering NO_x formation rates.

In-cylinder controls

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[13] E-mail from Roger Marx, ACT to Heather Preston, SCDHEC dated June 9, 2003.
[14] WRAP “Appendix C: NO_x Control Technology Summaries”.
www.wrapair.org/forums/mtf/documents/nox_pm/Section_VI_Appendices.doc

NESCAUM[15] states that some in-cylinder methods offer low to moderate NO_x reductions at costs well below $1,000/ton. These include injection timing retard, ignition timing retard, and air/fuel ratio adjustment (with or without high-energy ignition).

Low-Emission Combustion

NESCAUM[16] states that spark-ignited engines that can be retrofitted with Low-Emission Combustion (LEC) technology can potentially achieve significant NO_x reductions (80-90%). LEC technology can be expensive to retrofit on some engines, and it may not be available from all engine manufacturers. For large, low-speed engines, LEC is estimated to provide annual NO_x reductions of about 80% at under $1,000/ton under most conditions. LEC technology is estimated to be more cost effective on smaller, medium speed engines (under $500/ton for annual control under most conditions). It is estimated to be somewhat more expensive for dual-fuel engines (annual control at a capacity factor of 65% is estimated to cost under $1,000/ton).

The Western Regional Air Partnership (WRAP) [17] cites cost effectiveness for LEC at $190 – 700/ton at a 80 - 90% reduction of NO_x. The capital cost of retrofitting these engines depends on the engine BHP. For engines firing a single fuel, retrofits have been implemented costing $340/hp for 3,400hp engines. A lower capital cost is expected for smaller, medium-speed engines, about $200/hp. Dual-fuel engines have much greater capital costs. For these engines (larger than 1,000hp) the capital cost can be estimated by:

Capital Cost = $405,000 + ($450 x hp).

Stationary Gas Turbines

There are three generic types of emission controls in use for gas turbines, wet controls using steam or water injection to reduce combustion temperatures for NO_x control, dry controls using advanced combustor design to suppress NO_x formation and/or promote CO burnout, and post-combustion catalytic control to selectively reduce NO_x and/or oxidize CO emission from the turbine. Other recently developed technologies promise significantly lower levels of NO_x and CO emissions from diffusion combustion type gas turbines. These technologies are currently being demonstrated in several installations.

Wet Controls

Water or steam injection is a technology that has been demonstrated to effectively suppress NO_x emissions from gas turbines. The effect of steam and water injection is to increase the thermal mass by dilution and thereby reduce peak temperatures in the flame zone. With water injection, there is an additional benefit of absorbing the latent heat of vaporization from the flame zone. Water or steam is typically injected at a water-to-fuel weight ratio of less than one.

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[15] NESCAUM. "Executive Summary: Status Report on NO_x Controls for: Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines. Technologies & Cost Effectiveness." December 2000.
[16] NESCAUM. "Executive Summary: Status Report on NO_x Controls for: Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines. Technologies & Cost Effectiveness." December 2000.
[17] WRAP "Appendix C: NO_x Control Technology Summaries".
www.wrapair.org/forums/mtf/documents/nox_pm/Section_VI_Appendices.doc

			1993		1999	
NO_x Control Technology [18]	Turbine Output (MW)	Emission Reduction (ppm)	$/ton	Cents/kWh	$/ton	Cents/kWh
Water/steam	4-5	Unc. → 42	1,750 – 2,100	0.47 – 0.50	1,500 – 1,900	0.39 – 0.43
Water/steam	20 – 25	Unc.→42	980 – 1,100	0.24 – 0.27	980	0.24
Water/Steam	160	Unc.→42	480	0.15	480[47]	0.15[19]

GE LM2500 Water Injection and DLN Cost Estimate

GE Industrial and Marine indicated that the incremental capital cost of water injection for the LM2500 (23 MW) is $100,000.

The incremental capital cost of a DLN combustor for the LM2500 is $800,000. The incremental O&M cost for a LM2500 was estimated at $10-20/fired-hour that includes the cost of periodic major overhaul of the DLN combustor. Combustor overhaul is more complex in the LM2500 than in an industrial turbine equipped with can-annular combustors, such as the General Electric Frame 7FA, since the individual combustor "cans" are modular and can be removed and replaced quickly.

NESCAUM[20] estimates water injection installed on peaking units that operate 200 hours to 400 hours in the summer would reduce NO_x at a cost of about $2,500/ton to about $7,000/ton, depending upon the number of operating hours and the fuel used (gas or distillate oil).

Dry Controls

Two stage rich/lean combustors are essentially air-staged, premixed combustors in which the primary zone is operated fuel rich and the secondary zone is operated fuel lean. The rich mixture produces lower temperatures (compared to stoichiometric) and higher concentrations of CO and H_2, because of generation. Before entering the secondary zone, the exhaust of the primary zone is quenched (to extinguish the flame) by large amounts of air and a lean mixture is created. The lean mixture is pre-ignited and the combustion in a fuel lean, lower temperature environment.

	1993	1999

[18] From "Cost Analysis of NO_x Control Alternatives for Stationary Gas Turbines" Prepared by ONSITE SYCOM for USEPA 11/5/1999.

[19] The one baseload Frame 7F installed in 1990 is the only baseload 7F turbine that is equipped with steam injection. All subsequent 7F and 7FA baseload machines have been equipped with DLN. For this reason, the 1993 figures are assumed to be unchanged for steam injection.

[20] NESCAUM. "Executive Summary: Status Report on NO_x Controls for: Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines. Technologies & Cost Effectiveness." December 2000.

NO_x Control Technology [21]	Turbine Output (MW)	Emission Reduction (ppm)	$/ton	Cents/kWh	$/ton	Cents/kWh
DLN	4-5	Unc. → 42	820 – 1,050	0.16 – 0.19	NA[22]	NA
DLN	4-5	Unc. →25	NA[50]	NA	270 – 300	0.06 – 0.09
DLN	20 – 25	Unc.→25	530 – 1,050	0.16 – 0.19	210	0.12
DLN	170	Unc.→25	NA	NA	124	0.05
DLN	170	Unc.→9	NA	NA	120	0.55

GE Frame 7FA DLN Cost Estimate

GE Power Systems indicated that the cost to replace an existing steam-injected Frame 7FA combustor with a DLN combustor is $4,500,000 (installed). A definitive O&M cost for the Frame 7FA equipped with DLN has not been determined by GE Power Systems. GE Power Systems indicated that large baseload units such as the Frame 7FA are provided with spare combustors that are typically rotated every 8,000 to 12,000 hours. Combustor rotation eliminates the need for a separate 30,000 to 40,000 hour major combustor overall as is typical with smaller industrial units equipped with annular combustors.

The cost of DLN combustors can vary dramatically for the same size turbine offered by different manufacturers. As an example, the incremental cost of a DLN combustor for a new Solar Taurus 60 turbine (5.2 MW) is approximately $180,000. The incremental cost of a DLN combustor for a Rolls-Royce Allison 501-KB7 turbine (5.1 MW) is $20,000. The cost discrepancy is related to performance capabilities, design complexity and reliability/maintenance factors.

Solar Turbines Water Injection and DLN Cost Estimate

Turbine Model[23]	Size (MW)	Fuel	Price Range ($million)	Incremental Cost for Water Injection	Incremental Cost for DLN
Centaur 50	4.3	Natural gas	1.5 – 3.4	$45,000 - $96,000	$145,000 - $190,000
Taurus 60	5.2	Natural gas	1.7 – 3.6	$45,000 - $96,000	$165,000 - $190,000

NESCAUM[24] states "…retrofit of Dry Low NO_x on industrial turbines (about 3 to 10 MW) originally equipped with conventional combustion control is estimated to provide NO_x reductions under $2,000/ton for annual controls with high capacity factors and at a higher cost for seasonal controls. For larger turbines (~75 MW), cost was estimated to be well below $1,000/ton for nearly all conditions, and only a

[21] From "Cost Analysis of NO_x Control Alternatives for Stationary Gas Turbines" Prepared by ONSITE SYCOM for USEPA 11/5/1999.

[22] "NA" means technology that was not available in 1993, or technology that is obsolete in 1999.

[23] From "Cost Analysis of NO_x Control Alternatives for Stationary Gas Turbines" Prepared by ONSITE SYCOM for USEPA 11/5/1999.

[24] NESCAUM. "Executive Summary: Status Report on NO_x Controls for: Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines. Technologies & Cost Effectiveness." December 2000.

few hundred dollars per ton of NO_x reduced when the turbine was operated at a high capacity factor (~0.85)."

The Western Regional Air Partnership (WRAP) [25] cites cost effectiveness for DLN (fuel-lean combustion) at $1,000 – 2,000/ton at 70% reduction of NO_x. The cost of NO_x reduction by DLN is very sensitive to the capacity factor of the turbine. There is also substantial variation in capital cost measured in terms of dollars/horsepower ($/hp) due to different turbine types and variations in turbine design. Reported costs in case studies show capital costs ranging from $750 – 1,950K (4,700 hp at $160/hp and 13,000hp at $150/hp). These are total project costs that owners attributed to the project, which may include project management or other charges associated with the project beyond the equipment and installation.

Postcombustion Controls

Selective catalytic reduction (SCR) systems selectively reduce NO_x emissions by injecting ammonium (NH_3) into the exhaust gas stream upstream of a catalyst. Nitrogen oxides, NH_3, and O_2 react on the surface of the catalyst to form N_2 and H_2O. The exhaust gas must contain a minimum amount of O_2 and be within a particular temperature range (typically 450°F to 850°F) in order for the SCR system to operate properly.

The temperature range is dictated by the catalyst material which is typically made from noble metals, including base metal oxides such as vanadium and titanium, or zeolite-based material. The removal efficiency of an SCR system in good working order is typically from 65 to 90 percent. Exhaust gas temperatures greater than the upper limit (850°F) cause NO_x and NH_3 to pass through the catalyst unreacted. Ammonia emissions, called NH_3 slip, may be a consideration when specifying an SCR system.

Ammonia, either in the form of liquid anhydrous ammonia, or aqueous ammonia hydroxide is stored on site and injected into the exhaust stream upstream of the catalyst. Although an SCR system can operate alone, it is typically used in conjunction with water-steam injection systems or lean-premix system to reduce NO_x emissions to their lowest levels (less than 10ppm at 15 percent oxygen for SCR and wet injection systems). The SCR system for landfill or digester gas-fired turbines requires a substantial fuel gas pretreatment to remove trace contaminants that can poison the catalyst. Therefore, SCR and other catalytic treatments may be inappropriate control technologies for landfill or digester gas-fired turbines.

The catalyst and catalyst housing used in SCR systems tend to be very large and dense (in terms of surface area to volume ratio) because of the high exhaust flow rates and long residence times required for NO_x, O_2, and NH_3, to react on the catalyst. Most catalysts are configured in a parallel-plate, "honeycomb" design to maximize the surface area-to-volume ratio of the catalyst. Some SCR installations incorporate CO catalytic oxidation modules along with the NO_x reduction catalyst for simultaneous CO/NO_x control.

			1993		1999	
NO_x Control Technology [26]	Turbine Output (MW)	Emission Reduction (ppm)	$/ton	Cents/kWh	$/ton	Cents/kWh

[25] WRAP "Appendix C: NO_x Control Technology Summaries". www.wrapair.org/forums/mtf/documents/nox_pm/Section_VI_Appendices.doc

[26] From "Cost Analysis of NOx Control Alternatives for Stationary Gas Turbines" Prepared by ONSITE SYCOM for USEPA 11/5/1999.

Conventional SCR	170	42→9	3,600	0.23	1,940	0.12
High temp. SCR	170	42→9	3,600	0.23	2,400	0.13

MHIA Conventional SCR Cost Estimate

Mitsubishi Heavy Industries America (MHIA) is the principal supplier of conventional SCR to the gas turbine market in the U.S. According to MHIA, advances in SCR technology in the past two years have resulted in a 20 percent reduction in the amount of catalyst required to achieve a given NO_x target level. In addition, experience gained in the design and installation of SCR units has lowered engineering costs. These two factors have substantially reduced the cost of SCR systems since the 1993 NO_x ACT document. Operating costs have been reduced through innovations such as using hot flue gas to pre-heat ammonia injection air which lowers the power requirements of the ammonia injection system. Manufacturer's data uses water/steam injection as an upstream treatment (42 ppm of NO_x inlet to SCR).

Conventional SCR must be placed between sections of the HRSG so that the catalyst operates at the correct temperature. Obviously, this requirement is more cost effective when the HRSG is fitted in the shop rather than in a field retrofit. The cost estimate presented in Appendix A does not include any additional costs associated with modifying the HRSG to accept the SCR. The cost of this modification is dependent on the particular design and in many cases is not a significant cost adder.

Catalyst life is estimated at seven (7) years based on industry operating experience and is not a guaranteed life offered by SCR manufacturers.

Tecnip Low Temperature SCR Cost Estimate

Tecnip (formerly Kinetics Technology International) manufactures a low temperature SCR that is designed for retrofit installations with single digit NO_x emission targets. Low temperature SCR systems are installed downstream of an existing HRSG and avoid modification of the HRSG that would be required to accommodate a conventional SCR system. Manufacturer's data uses no pre-treatment for NOx.

Engelhard High Temperature SCR Cost Estimate

The high temperature SCR provided by Engelhard uses a zeolite catalyst to permit continuous operation at temperatures up to 1,100°F. The high temperature resistance of the zeolite catalyst allows for SCR installations on base-loaded simple cycle gas turbines (no heat recovery.) Simple cycle gas turbines generally have exhaust temperatures ranging from 950 to 1,050°F at rated load. At part loads, exhaust temperatures can be 100°F higher than rated conditions and can cause performance to decline. Prolonged exposure over 1,100ºF can cause slightly lower performance due to thermal aging. To prevent damage at sustained part load operation where temperatures will be above 1,100ºF, a tempering air system may be included to moderate exhaust temperatures. Manufacturer's data uses water/steam injection as an upstream treatment (42 ppm of NO_x inlet to SCR).

NESCAUM[27] also states that the cost of NO_x reduction with SCR varies considerable according to application, turbine size, and the type of SCR technology that is appropriate for the application. Conventional SCR on a large (~75 MW) combined-cycle turbine with high capacity factors was estimated to cost about $440/ton for annual controls and $870/ton for seasonal controls, for turbines equipped with conventional combustion technology (baseline NO_x emissions of 154ppm). For turbines with lower baseline NO_x emissions (such as those equipped with DLN combustors having baseline NO_x emissions of 15ppm), the cost per ton of additional NO_x removal was estimated to be greater, ranging from about $3,700/ton (annual control, high capacity factor) to over $13,000/ton (seasonal controls, low capacity factor). On smaller turbines (~5 MW), the cost of conventional SCR is estimated to be as low as $1,300/ton (with annual control and conventional combustion technology having baseline NO_x emissions of 142 ppm). Seasonal controls for smaller turbines are estimated at over $15,000/ton of NO_x removed at a low capacity factor (45%) with baseline NO_x emissions of 42 ppm.

For high and low temperature SCR applications, NESCAUM[28] found that a 75MW turbine at a high capacity factor and equipped with conventional combustion technology (baseline NO_x emissions of 154ppm) can be controlled annually with high- or low-temperature SCR for about $550/ton and for about $1,200/ton seasonally. The estimated cost of NO_x reduction for a 75MW turbine with baseline NO_x of 15ppm ranges from $5,170/ton (annual controls, high capacity factor of 85%) to as high as $20,000/ton (seasonal controls, low capacity factor of 45%). On smaller turbines (~5MW), the cost for high- or low-temperature SCR is estimated to be as low as $2,000/ton with annual control and conventional combustion technology (baseline NO_x emissions of 142 ppm). Cost is estimated to range from $6,750/ton (annual controls, high capacity factor of 85%) to about $27,000/ton (seasonal controls, low capacity factor of 45%) with baseline NO_x emissions of 42ppm.

WRAP[29] cites selective catalytic reduction costs to be $500 – $10,000/ton at an approximate 90% reduction of NO_x. Capital costs for retrofit SCR systems to power generation sources are mostly with the range of $60/kW to about $140/kW. The lower end of this range applies to retrofits with nominal difficulty. The high end of the range would typically be associated with retrofits having significantly impeded construction access, extensive relocations, and difficult ductwork transitions. Operating costs are mainly driven by cost of reagent, energy penalty (pressure loss, ammonia vaporization), catalyst replacement and dedicated O&M costs.

Cement Kilns

Low NO_x Burners

NESCAUM [30] states that Low-NO_x Burners have been successfully used in the primary burn zone and especially in the precalciner kilns. Combustion techniques were estimated to provide NO_x reduction at a cost-effectiveness of under $1,000/ton (annual control, high capacity factor).

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[27] NESCAUM. "Executive Summary: Status Report on NO_x Controls for: Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines. Technologies & Cost Effectiveness." December 2000.

[28] NESCAUM. "Executive Summary: Status Report on NO_x Controls for: Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines. Technologies & Cost Effectiveness." December 2000.

[29] WRAP "Appendix C: NO_x Control Technology Summaries". www.wrapair.org/forums/mtf/documents/nox_pm/Section_VI_Appendices.doc

[30] NESCAUM. "Executive Summary: Status Report on NO_x Controls for: Gas Turbines, Cement Kilns, Industrial Boilers, Internal Combustion Engines. Technologies & Cost Effectiveness." December 2000.

Source: Supplemental Ozone Transport Rulemaking Regulatory Analysis Office of Air and Radiation; United States Environmental Protection Agency; April 7, 1998

				Average Cost per Ton of NO_x Reduced in $1990		
Source Type	Annual/ Seasonal	Control Technology	Percent Reduction	Small Unit*	Medium Unit*	Large Unit*
ICI Boilers-Natural Gas	A	LNB	50	2,242	804	804
	A	LNB + FGR	60	4,365	1,609	1,609
	A	OT + WI	65	823	471	471
	A	SCR – New	80	2,584	1,395	1,395
	S	SCR – New	80	6,039	3,201	3,201
	A	SNCR – New	50	4,470	1,778	1,778
	S	SNCR – New	50	9,774	3,353	3,353
ICI Boilers – Distillate Oil	A	LNB	50	1,814	757	757
	A	LNB + FGR	60	3,189	1,347	1,347
	A	SCR – New	80	3,231	1,744	1,744
	S	SCR – New	80	7,548	4,001	4,001
	A	SNCR – New	50	5,364	2,134	2,134
	S	SNCR – New	50	11,728	4,024	4,024
ICI Boilers – Residual Oil	A	LNB	50	952	400	400
	A	LNB + FGR	60	1,885	914	914
	A	SCR – New	80	1,723	1,616	1,616
	S	SCR – New	80	5,551	3,660	3,660
	A	SNCR – New	50	2,980	1,186	1,186
	S	SNCR – New	50	6,935	2,656	2,656
ICI Boilers – Wood/Bark/FBC	A	SNCR – Ammonia	55	1,576	1,576	1,314
ICI Boilers – Wood/Bark/Stoker	A	SNCR – Urea	55	2,351	1,647	1,376
ICI Boilers – Coal/Cyclone	A	SNCR – New	35	902	902	722
	S	SNCR – New	35	1,640	1,640	1,209
	A	Coal Reburn	50	1,821	566	341
	A	SCR – New	80	861	861	724
	S	SCR – New	80	1,988	1,988	1,663
	A	NGR	55	1,821	566	347

Source: Supplemental Ozone Transport Rulemaking Regulatory Analysis Office of Air and Radiation; United States Environmental Protection Agency; April 7, 1998

				Average Cost per Ton of NO_x Reduced in \$1990		
Source Type	Annual/ Seasonal	Control Technology	Percent Reduction	Small Unit*	Medium Unit*	Large Unit*
ICI Boilers – Coal/FBC	A	SNCR – Urea	75	995	995	876
ICI Boilers – Coal/Stoker	A	SNCR – New	40	1,762	1,762	1,410
	S	SNCR – New	40	3,201	3,201	2,360
ICI Boilers – Coal/Wall	A	SNCR – New	45	1,175	1,175	940
ICI Boilers – Coal/Wall	S	SNCR – New	45	2,134	2,134	1,574
	A	LNB	50	1,476	1,476	1,195
	A	SCR – New	80	1,436	1,436	1,208
	S	SCR – New	80	3,316	3,316	2,774
ICI Boilers – Coke	A	SNCR – New	40	1,180	1,180	940
	S	SNCR – New	40	2,130	2,130	1,570
	A	LNB	50	1,305	1,305	1,305
	S	LNB	50	3,113	3,113	3,113
	A	SCR – New	70	1,440	1,440	1,210
	S	SCR – New	70	3,320	3,320	2,770
Internal Combustion Engines – Gas	A	IR	20	756	514	514
	A	AF Ratio	20	2,002	399	399
	A	AF + IR	30	1,950	476	476
	A	L-E (Medium Speed)	87	423	NA	NA
	A	L-E (Low Speed)	87	2,068	666	666
	A	NSCR	90	3,431	264	264
IC Engines – Gas, Diesel, LPG	A	IR	25	518	518	518
	S	IR	25	1,236	1,236	1,236
	A	SCR	80	1,540	1,540	1,540
	S	SCR	80	3,674	3,674	3,674
IC Engines – Oil	A	IR	25	1,588	366	366
	A	SCR	80	9,367	651	651
Gas Turbines – Jet Fuel	A	Water Injection	68	1,213	1,213	1,213

Source: Supplemental Ozone Transport Rulemaking Regulatory Analysis Office of Air and Radiation; United States Environmental Protection Agency; April 7, 1998

Source Type	Annual/ Seasonal	Control Technology	Percent Reduction	Average Cost per Ton of NO_x Reduced in $1990		
				Small Unit*	Medium Unit*	Large Unit*
	S	Water Injection	68	2,894	2,894	2,894
	A	SCR + Water Injection	90	5,400	5,400	5,400
	S	SCR + Water Injection	90	12,882	12,882	12,882
Gas Turbines – Natural Gas	A	Water Injection	76	1,507	747	542
	A	Steam Injection	80	1,693	823	566
	A	LNB	84	632	290	157
	A	SCR + LNB	94	20,450	13,000	7,300
	A	SCR + Steam Injection	95	9,500	7,120	3,530
Gas Turbines – Natural Gas	A	SCR + Water Injection	95	10,150	4,500	5,230
Gas Turbines – Oil	A	Water Injection	68	1,094	604	476
	A	SCR + Water Injection	90	8,340	2,690	2,430
Cement Manufacturing – Dry	A	Mid-Kiln Firing	25	540	540	540
	S	Mid-Kiln Firing	25	1,288	1,288	1,288
	A	LNB	25	670	670	670
	S	LNB	25	1,598	1,598	1,598
	A	SNCR – Urea Based	50	850	850	850
	S	SNCR – Urea Based	50	2,028	2,028	2,028
	A	SNCR – NH_3 Based	50	960	960	960
	S	SNCR – NH_3 Based	50	2,290	2,290	2,290
	A	SCR	80	4,040	4,040	4,040
	S	SCR	80	9,638	9,638	9,638
Cement Manufacturing – Wet	A	Mid-Kiln Firing	25	490	490	490
	S	Mid-Kiln Firing	25	1,169	1,169	1,169
	A	LNB	25	640	640	640
	S	LNB	25	1,527	1,527	1,527
	A	SCR	80	3,370	3,370	3,370
	S	SCR	80	8,040	8,040	8,040

Source: Supplemental Ozone Transport Rulemaking Regulatory Analysis Office of Air and Radiation; United States Environmental Protection Agency; April 7, 1998				Average Cost per Ton of NO_x Reduced in $1990		
Source Type	Annual/ Seasonal	Control Technology	Percent Reduction	Small Unit*	Medium Unit*	Large Unit*
Lime Kilns	A	Mid-Kiln Firing	25	540	540	540
	S	Mid-Kiln Firing	25	1,288	1,288	1,288
	A	LNB	25	670	670	670
	S	LNB	25	1,598	1,598	1,598
	A	SNCR – Urea Based	50	850	850	850
	S	SNCR – Urea Based	50	2,028	2,028	2,028
	A	SNCR – NH_3 Based	50	960	960	960
	S	SNCR – NH_3 Based	50	2,290	2,290	2,290
	A	SCR	80	4,040	4,040	4,040
	S	SCR	80	9,638	9,638	9,638
Municipal Waste Combustors	A	SNCR	45	2,670	2,670	2,670
	S	SNCR	45	6,370	6,370	6,370
Process Heaters – Distillate Oil	A	LNB	45	4,085	1,142	1,142
	A	LNB + FGR	48	4,976	1,946	1,946
	A	SNCR	60	3,659	1,936	1,936
	S	SNCR	60	6,352	3,361	3,361
	A	ULNB	74	2,517	711	711
	A	SCR	75	10,648	7,047	7,047
	S	SCR	75	21,871	14,475	14,475
	A	LNB + SNCR	78	4,201	2,159	2,159
	S	LNB + SNCR	78	7,743	3,978	3,978
	A	LNB + SCR	92	10,551	6,137	6,137
	S	LNB + SCR	92	21,704	12,624	12,624
Process Heaters – Natural Gas	A	LNB	50	2,464	2,696	2,110
	A	LNB + FGR	55	3,891	3,635	2,865
	A	SNCR	60	3,814	2,744	2,226
	S	SNCR	60	6,934	4,989	4,048

Source: Supplemental Ozone Transport Rulemaking Regulatory Analysis Office of Air and Radiation; United States Environmental Protection Agency; April 7, 1998

				Average Cost per Ton of NO_x Reduced in $1990		
Source Type	Annual/ Seasonal	Control Technology	Percent Reduction	Small Unit*	Medium Unit*	Large Unit*
	A	ULNB	75	1,704	1,641	1,413
	A	SCR	75	16,214	11,664	9,419
	S	SCR	75	30,839	22,186	17,914
	A	LNB + SNCR	80	4,400	3,746	2,981
	S	LNB + SNCR	80	8,381	7,136	5,680
	A	LNB + SCR	88	15,294	11,519	9,273
	S	LNB + SCR	88	30,359	22,866	18,408
Process Heaters – Other Fuels	A	LNB + FGR	34	1,650	1,650	1,650
	S	LNB + FGR	34	3,936	3,936	3,936
	A	LNB	37	858	858	858
	S	LNB	37	2,047	2,047	2,047
	A	SNCR	60	1,280	1,280	1,280
	S	SNCR	60	3,054	3,054	3,054
	A	ULNB	73	442	442	442
	S	ULNB	73	1,054	1,054	1,054
	A	LNB + SNCR	75	1,450	1,450	1,450
Process Heaters – Other Fuels	S	LNB + SNCR	75	3,459	3,459	3,459
	A	SCR	75	4,330	4,330	4,330
	S	SCR	75	10,330	10,330	10,330
	A	LNB + SCR	91	3,820	3,820	3,820
	S	LNB + SCR	91	9,113	9,113	9,113
Process Heaters – Process Gas	A	LNB	50	788	788	788
	S	LNB	50	1,880	1,880	1,880
	A	LNB + FGR	55	1,136	1,136	1,136
	S	LNB + FGR	55	2,710	2,710	2,710
	A	SNCR	60	981	981	981
	S	SNCR	60	2,340	2,340	2,340

Source: Supplemental Ozone Transport Rulemaking Regulatory Analysis Office of Air and Radiation; United States Environmental Protection Agency; April 7, 1998				Average Cost per Ton of NO_x Reduced in $1990		
Source Type	Annual/ Seasonal	Control Technology	Percent Reduction	Small Unit*	Medium Unit*	Large Unit*
	A	ULNB	75	532	532	532
	S	ULNB	75	1,269	1,269	1,269
	A	SCR	75	4,023	4,023	4,023
	S	SCR	75	9,597	9,597	9,597
	A	LNB + SNCR	80	1,229	1,229	1,229
	S	LNB + SNCR	80	2,932	2,932	2,932
	A	LNB + SCR	88	3,905	3,905	3,905
	S	LNB + SCR	88	9,316	9,316	9,316
Process Heaters – Residual Oil	A	LNB + FGR	34	4,085	1,597	1,597
	A	LNB	37	2,962	831	831
	A	SNCR	60	2,207	1,239	1,239
	S	SNCR	60	3,679	2,065	2,065
	A	ULNB	73	1,510	428	428
	A	LNB + SNCR	75	2,652	1,404	1,404
	S	LNB + SNCR	75	4,732	2,504	2,504
	A	SCR	75	6,195	4,191	4,191
	S	SCR	75	12,688	8,584	8,584
	A	LNB + SCR	91	6,273	3,698	3,698
	S	LNB + SCR	91	12,871	7,588	7,588

Emission Size Ranges for Other Stationary Sources

Source Type	Small Unit	Medium Unit	Large Unit
ICI Boilers	<100 mmBtu/hr	≥100 mmBtu/hr & <250 mmBtu/hr	≥250 mmBtu/hr
Reciprocating IC Engines	<4,000 horsepower (hp)	≥ 4,000 hp & < 8,000 hp	≥ 8,000 hp

Gas Turbines	<10,000 hp	≥10,000 hp & <20,000 hp	≥20,000 hp
Any Other Source	<1 tpd	≥ 1 tpd & <2 tpd	≥ 2 tpd

Abbreviations and Acronyms

AF	air-fuel ratio	NSCR	non-selective catalytic reduction
FGR	flue gas recirculation	OT	oxygen trim
hp	Horsepower	SCR	selective catalytic reduction
IR	ignition retard	SNCR	selective non-catalytic reduction
LE	low emission	ULNB	ultra low NO_x burners
LNB	low NO_x burners	WI	water injection
NGR	natural gas recirculation		

Regulation 61-62.5, Standard 5.1, *Lowest Achievable Emission Rate (LAER) Applicable to Volatile Organic Compounds*

The Department is proposing to revise Regulation 61-62.5, Standard 5.1, *Lowest Achievable Emission Rate (LAER) Applicable to Volatile Organic Compounds,* to require Best Available Control Technology (BACT) instead of LAER controls to be applied to any new construction permit issued after the effective date of this revision when the net VOC emissions increase exceeds 100 tons per year. LAER controls represent the most stringent pollution controls available and sources subject to LAER controls are not allowed to consider economic costs when determining what pollution controls are to be installed. This revision will require more reasonable BACT controls on new construction that results in a net VOC emissions increase of greater than 100 tons per year. This is consistent with the Department's proposed regulation (61-62.5, Standard 5.2) for controlling NOx emissions which requires reasonable NOx controls on fuel combustion sources. The Department believes that the less costly VOC controls that will result from this revision will further offset the costs to the regulated community of the NOx controls that the Department is proposing with Regulation 61-62.5, Standard 5.2, while still being protective of the environment and public health.

Regulation 61-62.2, *Prohibition of Open Burning*

Another regulation that the Department is revising in an effort to reduce NOx emissions statewide as part of the EAC process is Regulation 61-62.2, *Prohibition of Open Burning*. The most significant revisions to this regulation are as follows: deleting the exception for the burning of household trash, deleting the exception for the burning of construction waste, and revising the exception for fires set for the purpose of firefighter training. The burning of household trash and construction waste presents health and environmental concerns for many communities. The smoke generated from these activities is a nuisance to some and a health threat to others with asthma or other respiratory problems. Furthermore, the Department spends a lot of staff time and resources responding to complaints relating to these activities. The Department believes that deleting the exception for the burning of household trash will not result in any significant cost or hardship because other disposal options are readily available. With respect to the exception for the burning of construction waste, the Department is revising this provision to allow only residential construction waste to be burned and this will only be allowed if it meets the provisions of the regulation. Again, this is not expected to result in any significant cost or hardship because many other practical disposal options are available and most construction sites currently use other means of waste disposal. The Department is also proposing to revise the exceptions for the purposes of firefighter training to ensure consistency and to ensure that minimum health, environmental and safety concerns are addressed. The Department will do a review of permanent firefighter training facilities and will evaluate non-permanent sites and require Department approval prior to a burn. The Department does not anticipate that this will result in any significant costs because existing firefighter training facilities will not be adversely impacted and non-permanent sites will still be allowed, but held to consistent standards. This revision allows the Department to collect information and to grant prior approval for firefighter training sites.